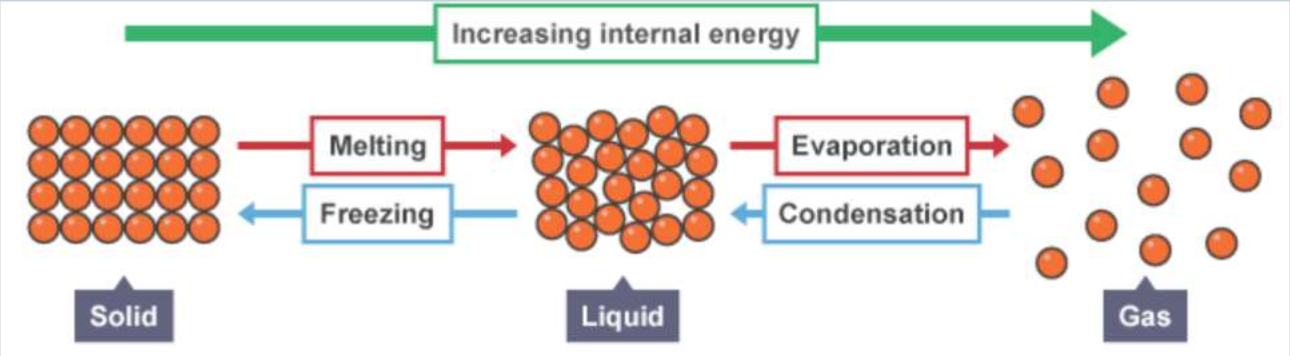
Molecules and Matter



Density:

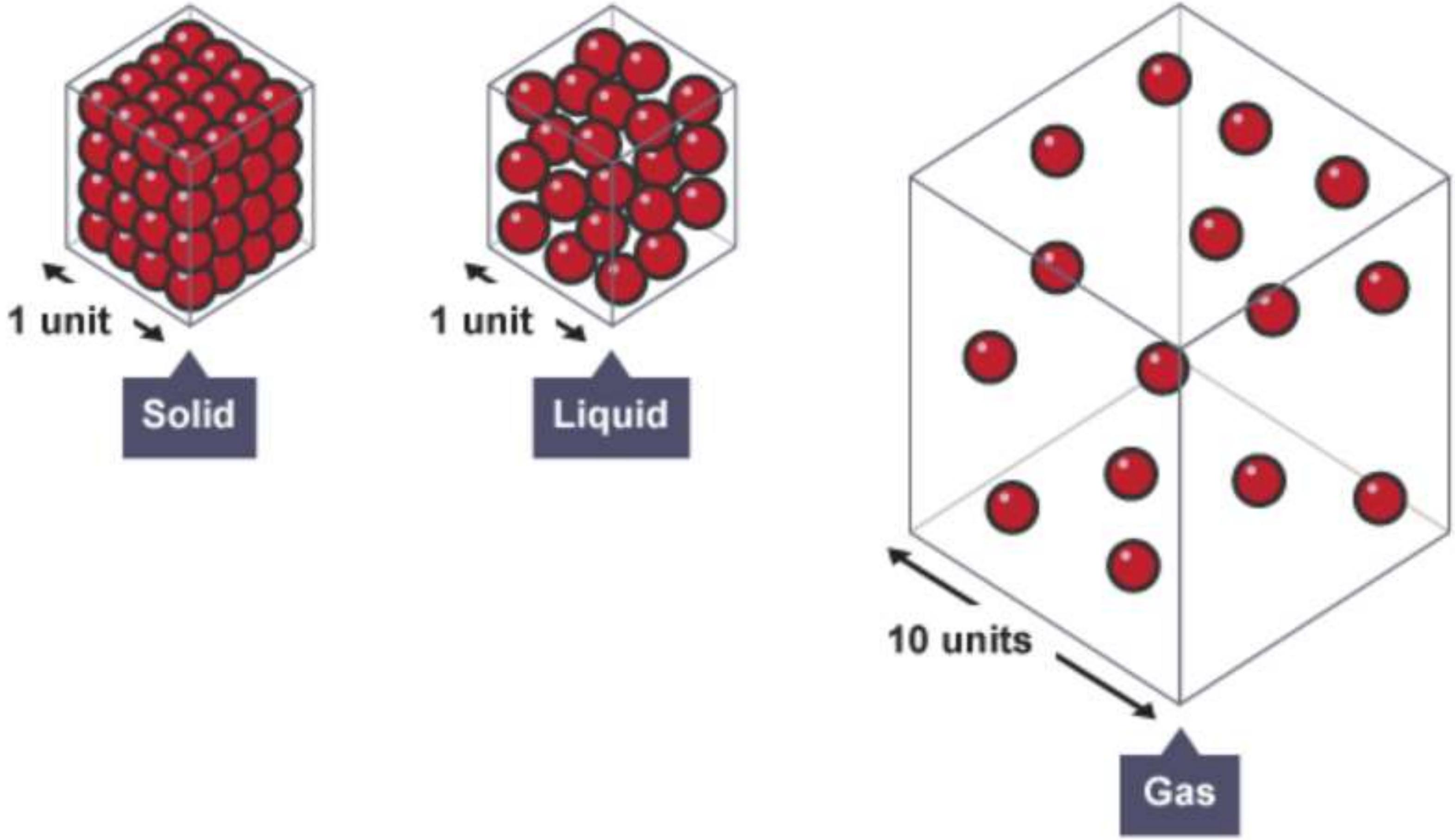
- The density of a substance is defined as its mass per unit volume
- Density can be calculated using the equation: $p = \frac{m}{V}$
- This is when:
- density (*p*) is measured in kilograms per metre cubed (kg/m^3)
- mass (*m*) is measured in kilograms (kg)
- volume (*V*) is measured in metres cubed (m^3)
- Objects with a density that is less than the densiy of a given liquid will float in that liquid

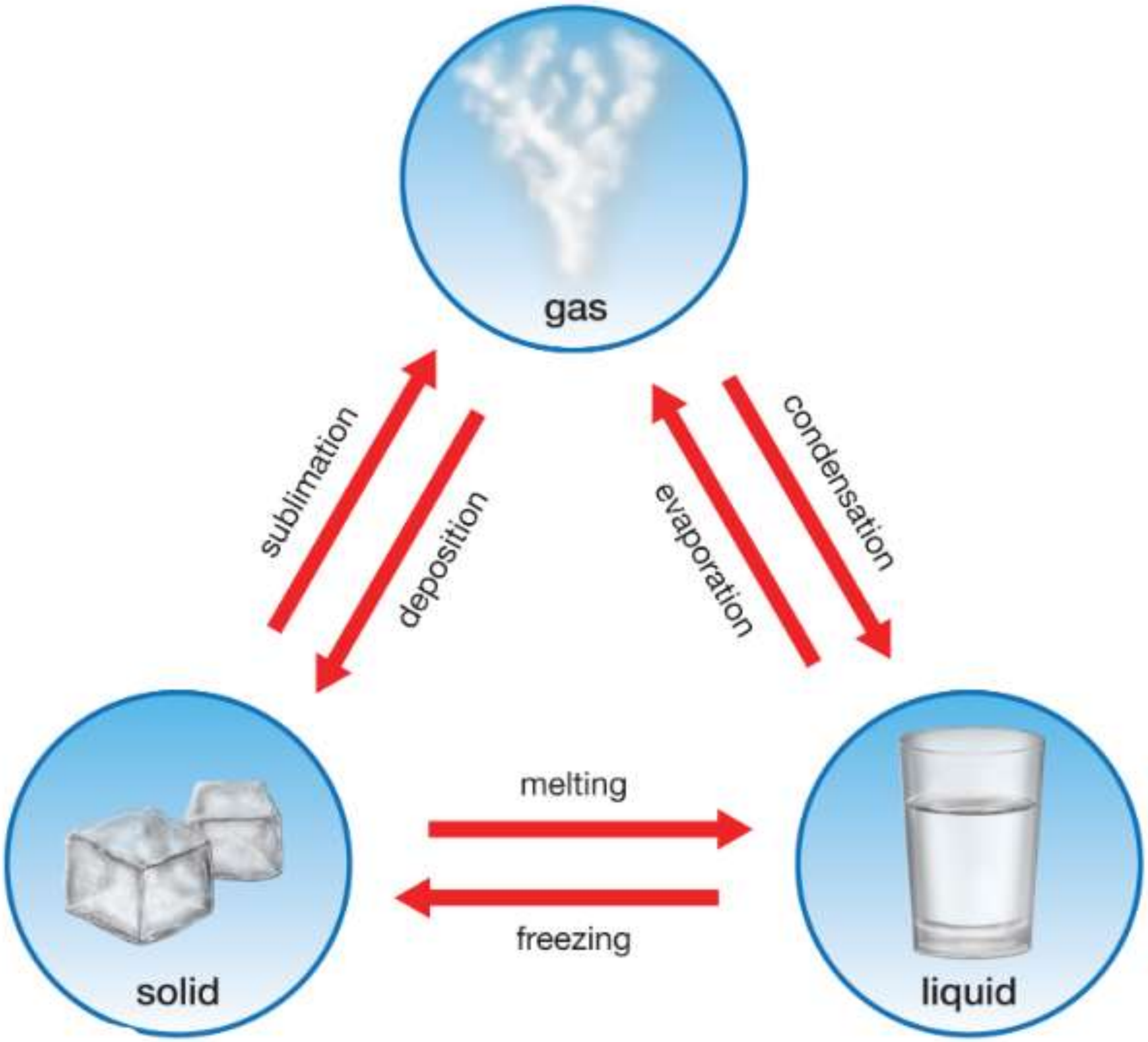
Density Tests:

- For a solid object, measure the mass using an electronic balance
- For a regular object (such as a cuboid) measure the lengths of the sides using a millimetre rule. Using this measurement, you can calculate volume
- For an irregular solid, lwer the object into a measuring cylinder of water until it is submerged – calculate the volume from the rise in water level
- For a liquid, measure the mass of an empty beaker. Pour liquid into beaker and measure new mass. Subtract mass of beaker to give mass of liquid.

States of Matter:

- All **matter** contains particles. The difference between the different states of matter is how the particles are arranged:
- in a solid - particles are tightly packed in a regular structure
- in a liquid - particles are tightly packed but free to move past each other
- in a gas - particles are spread out and move randomly


1 unit
Solid
1 unit
Liquid
10 units
Gas


gas
sublimation
deposition
evaporation
condensation
melting
freezing
solid
liquid

Internal Energy:

When a material is heated or cooled, two changes may happen to the particles within the material:

- Chemical **bonds** between the **particles** may form, break or stretch. There is a change in the chemical potential store of energy in the material.
- The material will heat up or cool down as the particles within it gain or lose speed. There is a change in the thermal store of energy within the material.
- **The internal energy is the total amount of kinetic energy and potential energy of all the particles in the system.**

Specific heat capacity

- **The specific heat capacity of a material is the energy required to raise one kilogram (kg) of the material by one degree Celsius (°C).**
- The amount of **thermal energy** stored or released as the temperature of a system changes can be calculated using the equation: $\Delta E_t = m \times c \times \Delta\theta$

This is when:

- change in thermal energy (ΔE_t) is measured in joules (J)
- mass (m) is measured in kilograms (kg)
- specific heat capacity (c) is measured in joules per kilogram per degree Celsius (J/kg°C)
- temperature change ($\Delta\theta$) is measured in degrees Celsius (°C)

Specific latent heat

- Changing the **internal energy** of a material will cause it to change temperature or change state:
- the energy required for a particular change in temperature is given by the **specific heat capacity**
- the energy required for a particular change in state is given by the **specific latent heat**
- **Specific latent heat is the amount of energy required to change the state of 1 kilogram (kg) of a material without changing its temperature.**

Specific latent heat

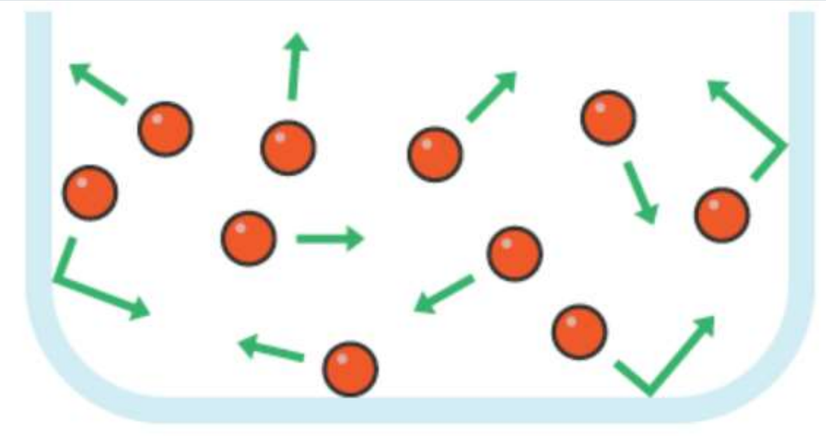
- As there are two boundaries, solid/liquid and liquid/gas, each material has two specific latent heats:
- latent heat of fusion - the amount of energy needed to **freeze** or **melt** the material at its melting point
- latent heat of vaporisation - the amount of energy needed to **evaporate** or **condense** the material at its boiling point

Particle motion

- The particles in a gas are moving very quickly in random directions.
- The speeds of the particles vary but, on average, they move quicker than they do in liquids and solids.
- This means that it does not take long for a gas to spread out to fill its entire container.
- The smell of an air freshener can spread all around a room very quickly.

Gas pressure

Since the particles in a gas are moving fast and randomly, collisions occur frequently. These collisions may be between two particles, between a particle and the wall of the container, or between a particle and something else in the container.



Gas pressure:

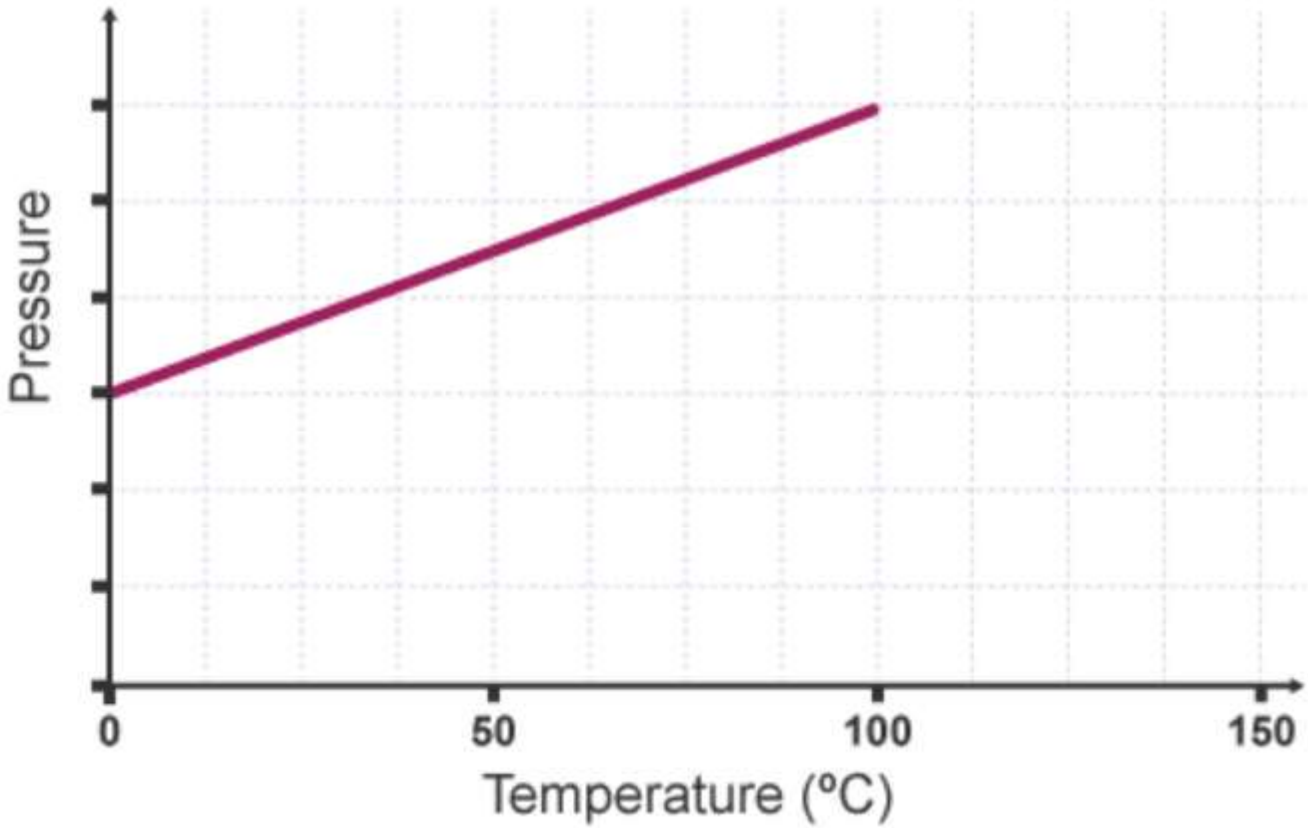
- The **pressure** caused by a gas can be calculated using the equation:

$$pressure = \frac{force}{area}$$

- This is when:
- pressure (*p*) is measured in newtons per metre squared (N/m^2)
- force (*F*) is measured in newtons (N)
- area (*a*) is measured in metres squared (m^2)

Pressure and Temperature:

- **The temperature of a gas is a measure of the average kinetic energy of its particles - the higher the temperature, the higher the average kinetic energy.**
- If the **volume** of a container with a gas inside stays the same, the pressure of a gas increases as its **temperature** increases.
- As the temperature increases, the pressure increases showing that pressure is directly **proportional** to temperature.


Pressure
0
50
100
150
Temperature (ºC)

Work and energy

Pressure can be increased by:

- increasing the **temperature** - this increases the force of each collision
- decreasing the **volume** - this increases the number of collisions per second